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Description of *Agelas cerebrum*, a new species and re-description of *A. dilatata* (Porifera)

Michael Assmann, Rob W. M. van Soest, and Matthias Köck

(MA and MK) Institut für Organische Chemie, Johann Wolfgang Goethe–Universität, Marie–Curie–Strasse 11, D–60439 Frankfurt, Germany; present address: Alfred-Wegener-Institut für Polar- und Meeresforschung, Am Handelshafen 12, D-27570 Bremerhaven, Germany; (RvS) Instituut voor Biodiversiteit en Ecosysteem Dynamica (Zoölogisch Museum), Universiteit van Amsterdam, P.O. Box 94766, 1090 GT Amsterdam, The Netherlands

Abstract.—Recent collections of sponges made in the Bahamas revealed the occurrence of two species of *Agelas,* which we could not assign to any of the currently recognised *Agelas* of the Western Atlantic. A comparison with literature records and extensive collections of *Agelas* incorporated in several major musea led us to conclude that several specimens belong to a species new to science, *Agelas cerebrum.* This species differs from the repent ramose form of *A. conifera* (Schmidt, 1870) in possessing a massively erect tube shape, thinner spicules and a higher number of whorls of spines. From the tubular form of *A. conifera* the new species differs in having much thicker tube walls with a system of convolutions and meandering grooves, and likewise differences in spicular dimensions. *Agelas cerebrum* differs from *A. tubulata* Lehnert & Van Soest, 1996 in having much thicker convoluted tubes and shorter spicules. A single thickly flabellate specimen we assign to *A. dilatata* Duchassaing & Michelotti, 1864, a species so far considered incertae sedis, because of compelling similarities with its original description and depiction. Our specimen differs from *A. clathrodes* in having a smooth plate form rather than an irregularly pitted wall-shape, and in having much more heavily cored primary fibres. It differs from *A. inaequalis* Pulitzer-Finali, 1986 because it is not cup-shaped and the spicules have more whorls of spines. It appears closest to *A. flabelliformis* (Carter, 1883) in shape and surface characteristics, but Carter's species forms very thin blades of 5 mm, whereas *A. dilatata* is 25–30 mm thick. *Agelas flabelliformis* has distinctly shorter and thinner spicules.

Sponges of the genus *Agelas* are common and dominant species in Caribbean reef communities. To date 21 nominal species have been described (Table 1) from this area. Compared to other areas of the world, the diversity of *Agelas* in the Caribbean is unusually high: elsewhere, only 12 nominal species from the whole of the Indo-Pacific, and 1 species from the Mediterranean (*Agelas oroides*), have been described. Although the genus is easily recognised, the systematics of *Agelas* at the species level appears problematic because of observed in-congruence of macroscopic features (shape, surface appearance and colour) and microscopical characters (arrangement of fibres and spicules, size and ornamentation of spicules) (Lehnert & Van Soest 1999). A revision of the genus is becoming urgent because of growing interest in the impact of *Agelas* on the reef community (e.g., Reiswig 1976, Hoppe 1988, Pawlik et al.1995, Chanas et al. 1996), as well as for its promising bioactive properties (Assmann et al. 1999, Assmann et al. 2000). The chemistry described for *Agelas* is characteristic, with

Table 1.—Nominal *Agelas* species recorded from the Caribbean. *A. dispar* has been reported in two distinct color forms indicated as (1) and (2).

Agelas arborescens	Lamarck, 1813 as *Spongia*
Agelas cervicornis	Schmidt, 1870 as *Chalinopsis*
Agelas citrina	Alcolado, 1984
Agelas clathrodes	Schmidt, 1870 as *Chalinopsis*; Carter, 1883 as *Ectyon sparsus*; Topsent, 1920 as *Agelas oroides*; De Laubenfels, 1949 as *Agelas sparsus*; De Laubenfels, 1953 as *Agelas oroides*; Collette & Rützler, 1977; Gomez & Green, 1984; Wintermann-Kilian & Kilian, 1984; Pulitzer-Finali, 1986; Zea, 1987; Gomez, 1992; Lehnert, 1993; Lehnert & Van Soest, 1996; Lehnert & Van Soest, 1998
Agelas clavaeformis	Carter, 1883 as *Ectyon sparsus* var.
Agelas conifera	Schmidt, 1870 as *Chalinopsis*; Wintermann-Kilian & Kilian, 1984; Pulitzer-Finali, 1986; Zea, 1987; Lehnert, 1993; Lehnert & Van Soest, 1996; Lehnert & Van Soest, 1998
Agelas cylindricus	Carter, 1883 as *Ectyon*
Agelas dilatata	Duchassaing & Michelotti, 1864
Agelas dispar (1)	Duchassaing & Michelotti, 1864 (orange); sensu Van Soest, 1981; Pulitzer-Finali, 1986; Lehnert, 1993; Lehnert & Van Soest, 1998 (= ?*Agelas clathrodes*)
Agelas dispar (2)	Duchassaing & Michelotti, 1864 (brown); Solé-Cava et al. 1981; Boury-Esnault, 1973; Wiedenmayer, 1977; Wintermann-Kilian & Kilian, 1984; Zea, 1987
Agelas flabelliformis	Carter, 1883 as *Ectyon*
Agelas inaequalis	Pulitzer-Finali, 1986
Agelas longissima	Pulitzer-Finali, 1986
Agelas marmarica	sensu Wintermann-Kilian & Kilian, 1984 (not: Lévi, 1958)
Agelas repens	Lehnert & Van Soest, 1998
Agelas rudis	Duchassaing & Michelotti, 1864
Agelas sceptrum	Lamarck, 1813 as *Alcyonium*; Topsent, 1933 as *Ectyon*; Lamarck, 1813 as *Spongia arborescens*; Topsent, 1931 as *Ectyon cervicornis*; Schmidt, 1870 as *Chalinopsis cervicornis*; Carter, 1883c as *Ectyon cylindricus*; Pulitzer-Finali, 1986 as *Agelas longissima*; Zea, 1987; Lehnert, 1993; Lehnert & Van Soest, 1998
Agelas schmidti	Wilson, 1902; Wintermann-Kilian & Kilian, 1984; Zea, 1987; Lehnert & Van Soest, 1998
Agelas sparsus	Gray, 1867; Hechtel, 1976
Agelas sventres	Lehnert & Van Soest, 1996; Lehnert & Van Soest, 1998
Agelas tubulata	Lehnert & Van Soest, 1996
Agelas wiedenmayeri	Alcolado, 1984

monomeric or dimeric molecules of brominated pyrrole-2-carboxylic acid derivatives uniformly present in all investigated species (Braekman et al. 1992). In addition, several species possess unusual diterpenic compounds. Investigations of *Agelas* species collected in the Bahamas, revealed the occurrence of many previously described forms (*A. cervicornis, A. clathrodes, A. dispar, A. sceptrum, A. wiedenmayeri*), as well as specimens which did not belong to those commonly recorded representatives of the genus. A comparison with literature records and extensive collections of Caribbean *Agelas* sponges incorporated in the collections of the Zoological Museum of Amsterdam and other museums, led us to conclude that the Bahamas material contained specimens of a species new to science. Furthermore, one specimen appeared to be so similar to old literature images and descriptions of *Agelas dilatata* Duchassaing & Michelotti, 1864 that we propose to revive this species. The purpose of the present study is to pro-

vide descriptions of these two *Agelas* species including comparative notes on species appearing similar.

Specimens of the new and the revived species were collected by the first author during a cruise of the R/V *Seward Johnson* to the Bahamas in July/August 1999. Large fragments were incorporated in the collections of the Zoological Museum of Amsterdam (numbers and locality data are provided below in conjunction with the descriptions) remaining parts of the specimens were used for extraction and chemical analysis. Specimens examined for comparison were obtained from the collections of the Zoological Museum of Amsterdam (ZMA), the United States National Museum, Washington (USNM), and the Natural History Museum, London (BMNH). For identification of sponges small fragments were cut off and stored in 70% ethanol. Spicule slides were studied using a JEOL JSM-35C scanning electron microscope.

Order Agelasida
Family Agelasidae Verrill, 1908
Agelas Duchassaing & Michelotti, 1864
Agelas cerebrum, new species
Fig. 1

Material examined.—Holotype ZMA POR. 15603, deep reef slope of Chub Cay, Bahamas, MAB96, 30 Jul 1999, 29.1 m.

Description.—Macroscopical features. Habit and surface characteristics: the type specimen consisted of two fused tubes (Fig. 1B, C), other specimens observed were only partly fused (Fig. 1A) or single. The height is up to 33 cm and 16 (single tube) to 22 cm (fused tubes) in diameter. Two vents (Fig. 1C), one 4.5 cm, the other 4–5 cm in diameter, leading to lumina of the same diameter penetrating deep into the sponge. The lumina come together at about 15 cm depth and continue to the base of the sponge as one hole. The inner wall contains numerous oscules flush with the smooth surface. The outer surface of the sponge is rough to the touch and is characteristically convoluted (Fig. 1A, B, D). About 20 convolutions appear over the whole length. Individual convolutions are 2.5–6 cm long and 1–3 cm wide. In the central part of the convolutions scattered smaller oscules are present (Fig. 1D). Separating convolutions on the surface are meandering groves, which are at least 2–3 cm in depth and a few mm in width. The color of the sponge is light brown to greyish brown in life. The consistency is tough, spongy, firm, and almost incompressible.

Microscopical features. Spicules: verticillated acanthostyles (Fig. 1E–G) as usual for the genus; they are quite variable in length and number of whorls; spicule sizes: 99-165 by 5–10 μm; number of whorls: 13–24, with 6 spines per whorl. Skeleton: mesh sizes vary 100–700 μm. Primary fibres are well developed, and easily recognised over long distances (200–600 μm). They are about 80–170 μm in diameter and are cored throughout the skeleton by 3–10 echinating spicules per 500 μm length of fibre. Both secondary and tertiary fibres are 60–120 μm in diameter, uncored, and echinated by 12 spicules per 500 μm length of fibre.

Remarks.—Among the described *Agelas* species of the Caribbean, the new species appears closest in gross morphology to *A. conifera* (Schmidt, 1870) and *A. tubulata* Lehnert & Van Soest, 1996.

Comparison with Agelas conifera.—Schmidt (1870) described *Chalinopsis conifera* as branch-like individuals with 8 mm wide oscula (Schmidt, 1870). Our material does not agree with this description. We were able to ascertain that the type specimen in the Copenhagen Museum conforms closely to Schmidt's description and is similar to the dominant form encountered among specimens identified by one of us (RvS) in the ZMA collections. We chose to compare the type of *A. cerebrum* with four ZMA specimens of similar growth form as Schmidt's type:

ZMA POR. 14197, Curaçao, "octopus-type", repent-ramose with volcanoe-shaped oscules: skeleton is a well-developed sys-

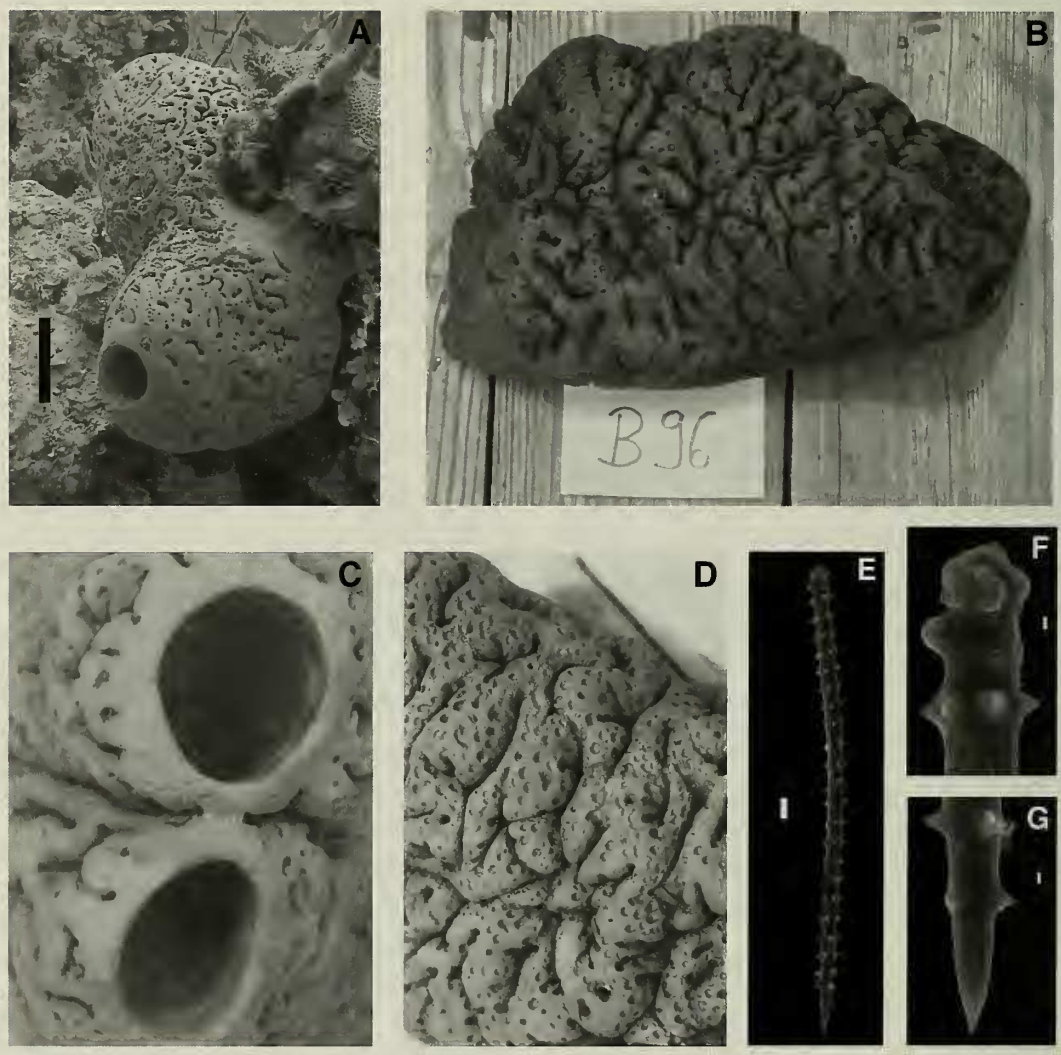

Fig. 1. *Agelas cerebrum* new species. A, habit photographed in situ (scale = 10 cm); B–D, holotype ZMA POR. 15603 (size quoted in text); E, acanthostyle of holotype (scale = 10 μm); F–G, details of acanthostyle (scale = 1 μm).

tem of primary and secondary fibres, easy to detect, penetrating deep into interior; primary fibres lie at distances of 400–700 μm and are cored with 5–9 spicules in cross section; thickness of primary fibres 60–100 μm; they are echinated by 6–7 spicules per 500 μm fibre length; secondary fibres are uncored, 30–60 μm in thickness; the echination of secondary fibres is about 8–12 per 500 μm fibre length. Meshes are 250–600 μm. Spicule sizes vary from 126–192 by 10–13 μm, with 11–15 whorls.

ZMA POR. 14170, Curaçao: similar to above, spicule sizes: 117–156 by 10–13 μm, with 11–16 whorls.

ZMA POR. 12778, Jamaica: similar to above, spicule sizes: 138–180 by 10–13 μm, with 11–14 whorls.

ZMA POR. 7783, Bahamas: similar to above, spicule sizes: 126–186 by 9–13 μm, 11–15 whorls.

There appears to be a consistent difference in spicule thickness and number of whorls, and they appear less variable, com-

pared to *Agelas cerebrum.* We also compared our sample with two specimens identified as *A. conifera* from Belize and Colombia displaying a tube form in growth. These tubes assigned to *A. conifera* are not grooved nor convoluted:

USNM unnumbered, Belize, P110, Carrie-Bow Cay, Belize, IMSWE Project, fore reef slope, 15–30 m, Rützler, col., id. 4 May 1973, on loan from the National Museum of Natural History, Smithsonian Institution: in total four tube individuals, up to 46 cm high, 8 cm in diameter, lumen 4 cm, surface is undulating but smooth, covered with zoanthids. Spicule sizes: 140–180 by 15–16 μm, with 11–16 whorls.

ZMA POR. 6148, Colombian Caribbean: 25 cm high, diameter of 6 cm, lumen of 3 cm in diameter, surface is undulating but smooth. Spicule sizes: 148–177 by 12–17 μm, 14–17 whorls.

In both *Agelas conifera* growth forms the spicules appear shorter and fatter, with a lower number of whorls, than in *A. cerebrum,* new species. The thickness overlaps only marginally with that of *A. cerebrum,* new species, spicules.

Comparison with Agelas tubulata *Lehnert & Van Soest, 1996.*—Specimens from Jamaica are long, brown, branching tubes (ZMA POR. 11323, ZMA POR. 13560), with individual tubes ca. 20–37 cm long, 3.5–5 cm in diameter, central aperture 2–2.5 cm in diameter. Numerous small (<1 mm) pores scattered over the smooth surface. A few larger (2–4 mm) apertures are visible. Choanosomal skeleton a reticulation of primary fibres, 40–70 μm in diameter, cored by 1–4 spicules, diverging to the surface, lying at distances of 300–400 μm apart, and interconnecting secondary fibres 20–50 μm diameter, forming almost square meshes. Spicule sizes: 78–210 by 5–12 μm, with 10–32 whorls. The major differences with *Agelas cerebrum* are thinner tubes, smooth unmarked surface and the greater upper length of the spicules.

Agelas dilatata Duchassaing & Michelotti, 1864
Fig. 2

Agelas dilatata Duchassaing & Michelotti, 1864: 77, pl. II fig. F, XIV fig. 1; van Soest et al., 1983: 197.

Material examined.—ZMA POR. 15604, Little San Salvador, Bahamas, MAB118, 3 Aug 1999, 23.4 m.

Description.—Macroscopical features. Habit and surface characteristics (Fig. 2A–D): flabellate; wedge-shaped; pedunculate. The height of the specimen is up to 35 cm and 41 cm in diameter, thickness 2.5–3 cm. One side (upper side, Fig. 2C) with 15 oscules per 25 square cm. Width of the oscules is 4–5 mm in diameter and they are flush with the smooth surface. Stalk (Fig. 2B) with few oscules, width of oscules 7–9 mm in diameter. The other side (Fig. 2D) with scattered fields of small apertures, slightly rough, uneven, with shallow depressions. The color of the upper side is orange brown, whereas the underside is bright orange in color. The consistency is slightly compressible, tough, spongy, firm, almost incompressible.

Microscopical features. Spicules (Fig. 2E, G): verticillated acanthostyles as usual for the genus; they are quite variable in length and number of whorls; spicule sizes: 78–195 by 5–9 μm; number of whorls: 11–21, with 6 spines per whorl. Skeleton: special ectosomal skeleton is absent, choanosomal fibres protrude at the surface, causing the slightly rough feel of the surface. Skeleton consists of a reticulation of spongin fibres. General aspect of the skeleton is irregular without prominent primary fibres, only in the periphery they are easily recognisable, the reason of their in-distinctness is their frequent anastomosing and subdividing, individual fibres only detectable over a short stretch, in other places the skeleton is dense and irregular. Primary fibres are not well developed. They contain a core of 0–6 spicules in a cross section. In the periphery the primary fibres lie at distances of

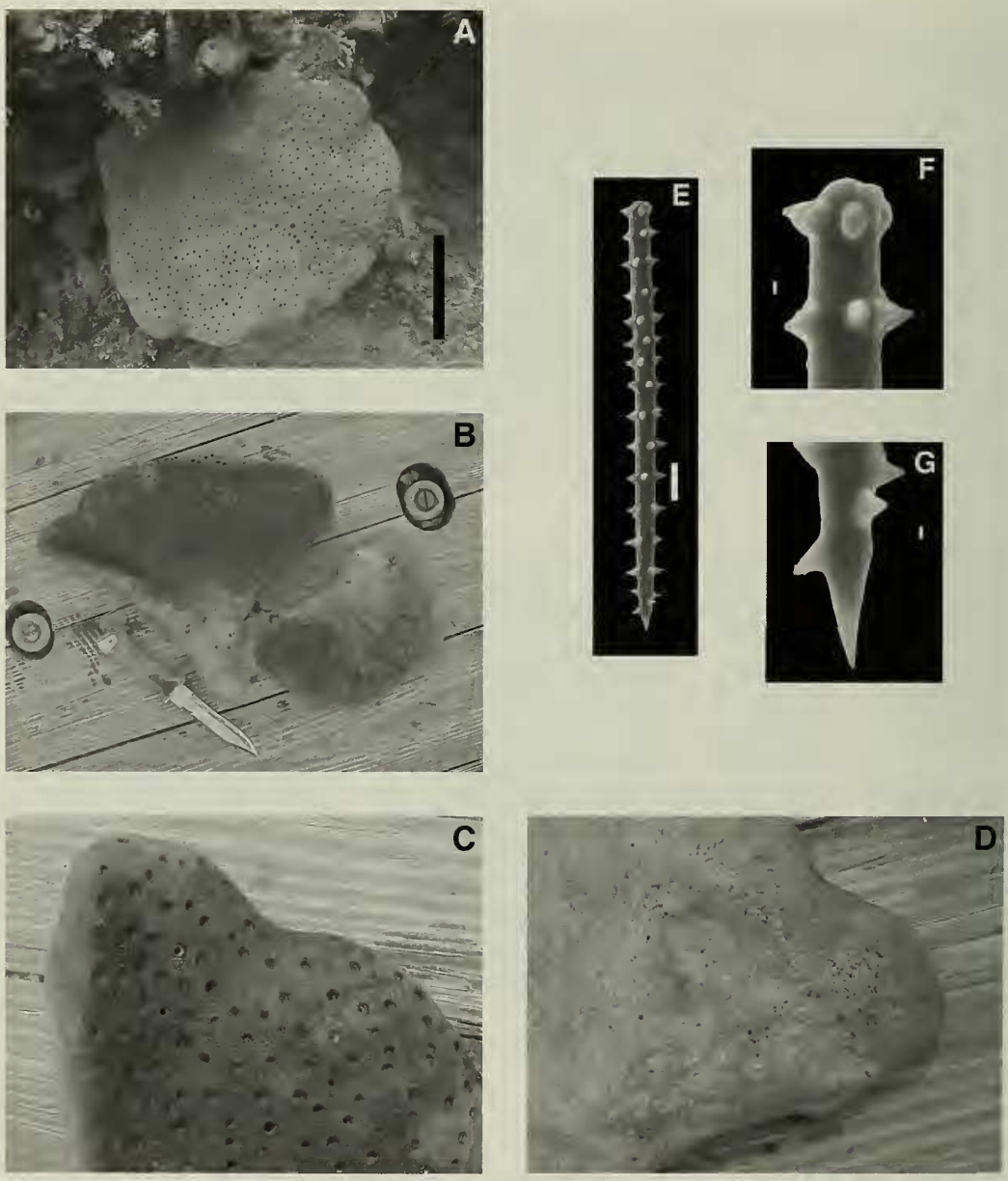

Fig. 2. *Agelas dilatata.* A, habit photographed in situ (scale = 10 cm); B–D, ZMA POR. 15604 (size quoted in text); E, acanthostyle (scale = 10 μm); F–G, details of acanthostyle (scale = 1 μm).

250–800 μm; thickness of the fibres 60–115 μm, they are echinated by 4–6 spicules over a distance of 500 μm fibre length. Although most primary fibres are only recognisable over short distance, occasionally they show a greater length. Interconnecting/secondary and tertiary fibres: they are arranged very irregularly and densely, they are mostly uncored but occasionally are cored by a single spicule; they are echinated by 6–12 spicules over a distance of 500 μm fibre length; sizes are largely similar to primaries: 25–100 μm, but quite variable. Meshes 50–400 μm.

Remarks.—We assign our specimen to *Agelas dilatata* because of the overall similarity with the Duchassaing & Michelotti's plate XIV fig. 1 (Duchassaing & Michelotti 1864). Also, their crude line drawings of the skeleton and the spicule (their pl. II fig. F) are more or less similar to microscopical details of our specimen. The one line description does not allow further confirmation, and unfortunately type material is no longer extant (Van Soest et al. 1983). No matching description so far appeared in the literature and we are confident that this is a valid species with characteristic morphology.

Comparison with similar species.—Among the described *Agelas* species of the Central West Atlantic, *A. dilatata* appears closest in gross morphology to *A. clathrodes* (Schmidt, 1870), *A. inaequalis* Pulitzer-Finali, 1986 and *A. flabelliformis* (Carter, 1883).

Agelas clathrodes (Schmidt, 1870 as *Chalinopsis*) is not likely to be our species. Schmidt's description refers to a bumpy surface and cavernous interior (Schmidt 1870). This description allows many interpretations, however, our specimen differs from it by the thin-bladed growth form, smooth surface, regularly and densely scattered oscules concentrated on one side only. The skeleton could be compared with a slide of a fragment of one of the types of *A. clathrodes* from the Copenhagen Museum. Compared with our *A. dilatata* specimen, it shows a less dense and much more regular reticulation, with clearly developed fibres: coring of primary fibres 6–12 spicules; primary fibres lie at distances further away from each other, 800–1100 μm; thickness of primary fibres about 100 μm; echination of fibres 6–7 spicules per 500 μm fibre length; secondary fibres are uncored; echination of secondary fibres: 7–10 spicules per 500 μm fibre length; thickness of secondary fibres: 40–70 μm; meshes: 100–500 μm.

Our specimen is not likely to belong to *Agelas inaequalis* Pulitzer-Finali 1986, because this is cup-shaped. The convex side is entirely perforated by apertures of 0.5–1 mm and 1–1.5 mm apart; on the inner side there are numerous oscules, sparse multiple oscules 5–10 mm wide, rather irregular. The fibres are only 45–90 μm thick, are abundantly echinated; coring spicules are observed only occasionally. Spicule sizes: 65–149 by 3.5–7 μm, with only 10–12 whorls with 3–4 spines each (Pulitzer-Finali 1986).

The present material is probably close to Carter's (1883) *Ectyon flabelliformis*. The type specimen only (not Carter's pictured specimen, which is probably *Agelas clathrodes*), BMNH 1884.4.14.9, was examined. It is likewise a thin-bladed species with scattered oscules on one side. However, the type specimen is three-lobed and the blade thickness is only 5 mm. We compared the skeleton of this species using a slide made from the type: it is similar in having a dense and irregular reticulation of spongin fibres; low spicular density, coring of main fibres is sparse, 0–3 spicules in a cross section; main fibres 50–90 μm in diameter; secondary fibres: 40–80 μm; echinating spicules about 12 over a distance of 500 μm fibre length. A distinct difference are the spicules. Compared with those of our *A. dilatata* specimen, they appear to be much shorter and thinner: 50–120 μm in length and by 3–6 μm width; sparsely developed whorls, spines irregularly distributed, here and there, 6–15 whorls.

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and *Agelas dilatata* were collected. Use of *R/V Seward Johnson* was made possible through funding from the NSF (OCE-9711255 to Joseph R. Pawlik). We thank the government of the Bahamas for permission to perform research in their territorial waters. RWMVS acknowledges receipt of the EC-Bioresource LSF project grant hosted by Ms. Clare Valentine and Ms. Vanessa Pike for a visit to the collections of the Natural History Museum, March 1999. Dr. Klaus Rützler and Ms. Kathleen P. Smith (NMNH, Washington) are thanked for the loan of Belizean tube-shaped *Agelas* specimens.

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